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Two new species of Protura (Arthropoda: Hexapoda) from Zhejiang, East China

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Abstract: Two new species of Protura are described: *Baculentulus wenyingae* **sp. nov**. and *Pseudanisentomon lishuiensis* **sp. nov**. *Baculentulus wenyingae* **sp. nov**. is characterized by the combined characters of the presence of foretarsal sensillum *b'*, differentiated sensilla on the maxillary palp, leaf-shaped sensillum on the labial palp, absence of *P1a* seta on tergites I–VI, eight anterior setae on tergite VI and 4/18 chaetotaxy on tergite VII. An updated key to the 13 *Baculentulus* species from China is also provided. *Pseudanisentomon lishuiensis* **sp. nov**. is characterized by the absence of foretarsal sensillum *b'-2*, *b* longer than *c*, the empodial appendage of II and III leg very short, the tergite I with 12 posterior setae, tergites V–VII lack seta *A3*, and sternites VIII–X with 2/7-4-4 chaetotaxy respectively. It was compared with the affiliated species *P. guangxiensis* (Yin & Zhang, 1982) in detail. In addition, a checklist and the distribution of 39 Protura species from Zhejiang Province are provided, and the Protura fauna in Zhejiang is also discussed.

Key words: proturans; sensillum; chaetotaxy; maxillary palp; key; taxonomy

中国浙江省原尾纲二新种记述（节肢动物门：六足亚门）

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摘要：记述中国浙江省原尾虫 2 新种：文英巴蚖 *Baculentulus wenyingae* **sp. nov.** 和丽水拟异蚖 *Pseudanisentomon lishuiensis* **sp. nov.**。文英巴蚖的鉴别特征是：前足跗节具有 *b'*感器，下唇须具有叶片状感器，下颚须的感器形态分化明显，腹部 I–VI 背板缺 *P1a* 毛，第 VI 背板具有 8 根前排刚毛，第 VII 背板的毛序为 4/18；文中修订更新了巴蚖属中国已知 13 种的检索表。丽水拟异蚖的鉴别特征是：前足跗节缺 *b'-2* 感器，外侧感器 *b* 长于 *c*，第 II 和 III 对足的中垫极短小，腹部第 I 背板具有 12 根后排刚毛，V–VII 背板缺 *A3* 毛，VIII–X 节毛序为 2/7-4-4，并与其近似种广西拟异蚖 *P. guangxiensis* (Yin & Zhang, 1982) 进行了详尽比较。文中提供了浙江省目前已知 39 种原尾虫的名录及其在浙江省的分布地，探讨了该省原尾虫的区系分布特征。

关键词：原尾虫；感器；毛序；下颚须；检索表；分类

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Introduction

So far, there are 215 species of Protura recorded in China (Bu *et al.* 2012, 2017, 2019). Zhejiang Province, located in subtropical area of China, has a high diversity of soil animals because of rich forest resources, diverse vegetation and high soil moisture. Since the first investigation of Protura from Zhejiang Province in 1963 (Yin 1963), thousands of proturan specimens have been obtained from over 300 sampling sites in the last 56 years, and 37 species have been identified (Yin 1999; Bu & Yin 2014a, b). When studying proturan material collected from Zhejiang in recent years, two new species were identified and are described in the present paper.

Material and methods

Specimens were extracted by means of Tullgren funnels from soil and litter samples, and preserved in 75% ethanol. They were mounted in Hoyer's solution and dried in an oven at 50°C. Observations were made with a phase contrast microscope. Line drawings were made using a drawing tube. All specimens are deposited in the collections of Shanghai Natural History Museum (SNHM), Shanghai, China.

Abbreviations used in the text follow the paper by Bu and Yin (2007). Head setae and pores names follow Rusek *et al.* (2012) and Shrubovych (2014). The arrangement of the taxa is according to the system proposed by Yin (1999).

Taxonomy

Family Berberentulidae Yin, 1983

Genus *Baculentulus* Tuxen, 1977

Baculentulus Tuxen, 1977: 601. Type species: *Berberentulus becki* Tuxen, 1976.

Diagnosis. Labial palps reduced to three setae and a sensillum. Canal of maxillary glands simple, with heart-shaped calyx. Foretarsal sensillum *t1* baculiform and *b'* present or absent. Abdominal appendages II–III each with two setae. Seta *P3* on tergites II–VI located anterior to the other *P*-setae row. Sternite VIII with 4/0 setae. Abdominal segment VIII with reduced striate band (Yin 1999; Galli *et al.* 2018).

Distribution. Cosmopolitan.

1. ***Baculentulus wenyingae*** **sp. nov.** (Figs. 1–3, Table 1)

Description. Adult body length 1250 µm (*n* = 2), yellow in color (Fig. 3A). Head elliptic, length 120 µm, width 85 µm, setae *sd4* and *sd5* short and sensilliform, *sd6* absent, frontal pore (*fp*) and clypeal pores (*cp*) present on dorsal side of head (Fig. 1A). Pseudoculus length 9 µm, PR = 13. Maxillary gland with smooth, heart-shaped calyx, with posterior filament length 18 µm, CF = 6.7 (Fig. 1B). Labial palps with three setae and one leaf-shaped sensillum (Fig. 1C). Maxillary palps with one parallel-side and one leaf-shaped sensillum (Fig. 1D).

Foretarsus. Length 97 µm, claw length 25 µm, TR = 3.9; empodium length 5 µm, EU = 0.2. Dorsal sensillum *t1* baculiform, *t2* thin and long, *t3* short and lanceolate, BS = 0.5. Exterior sensilla *a*, *c*, *d*, *e* and *f* filiform, apex of *a* surpassing base of *d*, *b* and *c* on same level, *b* broad at base and surpassing base of *f*, *d* closer to *c* than to *e*, *f* reaching base of claw, g broad and short (Fig. 1I). Interior sensillum *a'* very broad, close to *t1*, far surpassing base of *b'*, *b'* slender and its apex surpassing base of *δ5*, and *c'* filiform and reaching base of claw. (Fig. 1J). Relative length of sensilla: *t3* < *t1* < *g* < (*a* = *a'*) < (*t2* = *d* = *b'* = *c'*) < *e* < *c* < (*b* = *f*). Seta *β1* and *δ4* sensilliform, 6 μm and 8 μm in length respectively (Fig. 1J). Claw slender, without inner flap. Length of middle tarsus 40 μm, claw length 15 μm. Length of hind tarsus 45 μm, claw length 16 μm.

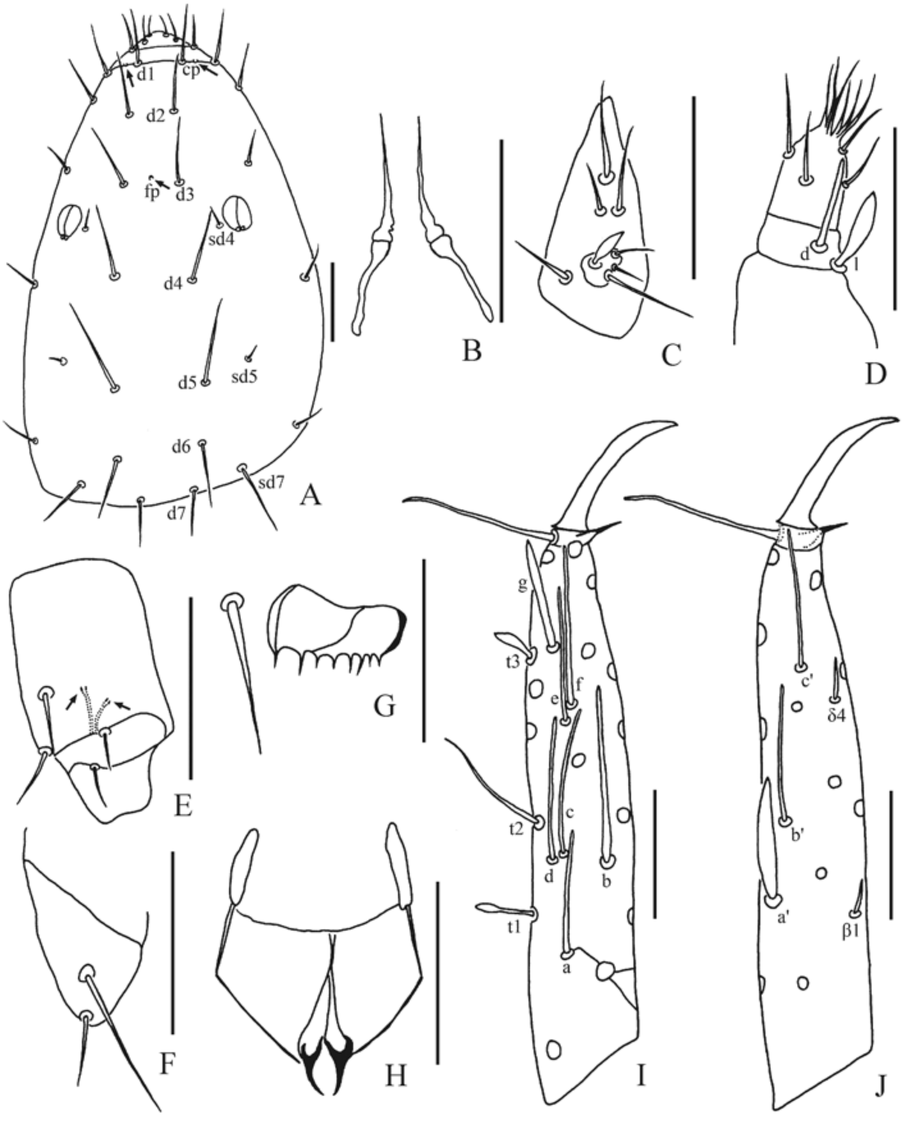

Figure 1. *Baculentulus wenyingae* **sp. nov.**, holotype. A. Head, dorsal view (*cp* = clypeal pore, *fp* = frontal pore); B. Canal of maxillary gland; C. Labial palpus; D. Maxillary palpus; E. Abdominal appendage I, arrows show the pores; F. Abdominal appendage II; G. Comb; H. Female squama genitalis; I. Foretarsus, exterior view; J. Foretarsus, interior view. Scale bars = 20 μm.

Thorax. Thoracic chaetotaxy formula given in Table 1. Setae *1* and *2* on pronotum 25–27 µm and 14–16 µm respectively. On meso- and metanotum, *A2* subequal to *M*. Accessory setae *P1a* and *P2a* on meso- and metanotum short and sensilliform (Fig. 2A). Setae *P1*, *P1a* and *P2* on mesonotum 20, 2 and 25 µm. Seta *P5* on mesonotum pin-shaped, on metanotum rudimentary (Fig. 2A). Setae *A2* and *M2* on prosternum, *A2* on meso- and metasternum sensilliform, 4–5 µm in length (Figs. 3B, C, E). Mesonotum with pores *al* and *sl*, metanotum with pore *sl* only (Fig. 2A). Pro-, meso- and metasternum without pores (Figs. 3B, C, E).

Table 1. Adult chaetotaxy of *Baculentulus wenyingae* sp. nov.

Segment		Dorsal		Ventral	
		Formula	Setae	Formula	Setae
Th.	I	4	1, 2	$\frac{4-4}{6}$	A1, 2, M1, 2 P1, 2, 3
	II–III	$\frac{6}{16}$	A2, 4, M P1, 1a, 2, 2a, 3, 3a, 4, 5	$\frac{7-2}{4}$	Ac, 2, 3, 4, M P1, 2
Abd.	I	$\frac{6}{10}$	A1, 2, 5 P1, 2, 2a, 3, 4	$\frac{3}{2}$	Ac, 2 P1
	II–III	$\frac{6}{14}$	A1, 2, 5 P1, 2, 2a, 3, 4, 4a, 5	$\frac{3}{5}$	Ac, 2 Pc, 1a, 2
	IV–V	$\frac{6}{14}$	A1, 2, 5 P1, 2, 2a, 3, 4, 4a, 5	$\frac{3}{8}$	Ac, 2 P1, 1a, 2, 3
	VI	$\frac{8}{14}$	A1, 2, 4, 5 P1, 2, 2a, 3, 4, 4a, 5	$\frac{3}{8}$	Ac, 2 P1, 1a, 2, 3
	VII	$\frac{4}{18}$	A4, 5 P1, 1a, 2, 2a, 3, 3a, 4, 4a, 5	$\frac{3}{8}$	Ac, 2 P1, 1a, 2, 3
	VIII	$\frac{6}{16}$	A1, 4, 5 M1, 2, 3, 4, P2, 3, 4, 5	$\frac{4}{0}$	1, 2
	IX	14	1, 1a, 2, 2a, 3, 3a, 4	4	1, 2
	X	12	1, 2, 2a, 2a, 3, 4	4	1, 2
	XI	6	1, 3, 4	4	1, 3
	XII	9		6	

Abdomen. Abdominal chaetotaxy given in Table 1. Tergites I–V with three pairs of *A*-setae (Figs. 2B, D, F), VI with four pairs of *A*-setae (Figs. 2E, G), VII with two pairs of *A*-setae (Figs. 2C, H). Seta *P3* on tergites II–VI anterior to other *P*-row setae (Figs. 2D, E, 3F), and the same level with other *P*-row setae on tergites I and VII (Figs. 2B, C). Sternite I with one pair of *P*-setae, sternites II–III each with 5 *P*-setae (Fig. 3G). Sternites IV-VII each with 8 *P*-setae (Figs. 2F–H, 3H, J). Seta *P1a* absent on tergites I–VI, present on tergite VII. Accessory setae on tergites and sternites I–VII short, sensilliform, 3–5 µm in length (Figs. 2B–H).

Tergite I with pores *psm* (Fig. 2B). Tergites II–VI with pores *psm* and *al* (Figs. 2D–G), VII with pores *psm*, *psl* and *al* (Figs. 2C, H). Pore *psm* on tergite VIII present. Tergites IX–XI without pores, XII with single median pore on serrate line. Sternites I–IV without pores, V-VII each with 1 posterior medial pore asymmetrically (Figs. 2F–H). Membrane between tergites and sternites V–VI each with 2 + 2 anteromembranal (*amb*) pores (Figs. 2F, G, 3D), and 1 + 1 *amb* pores on sternite VII (Fig. 2H). Sternites VIII–XI without pores. Sternite XII with 1 + 1 anterolateral pores.

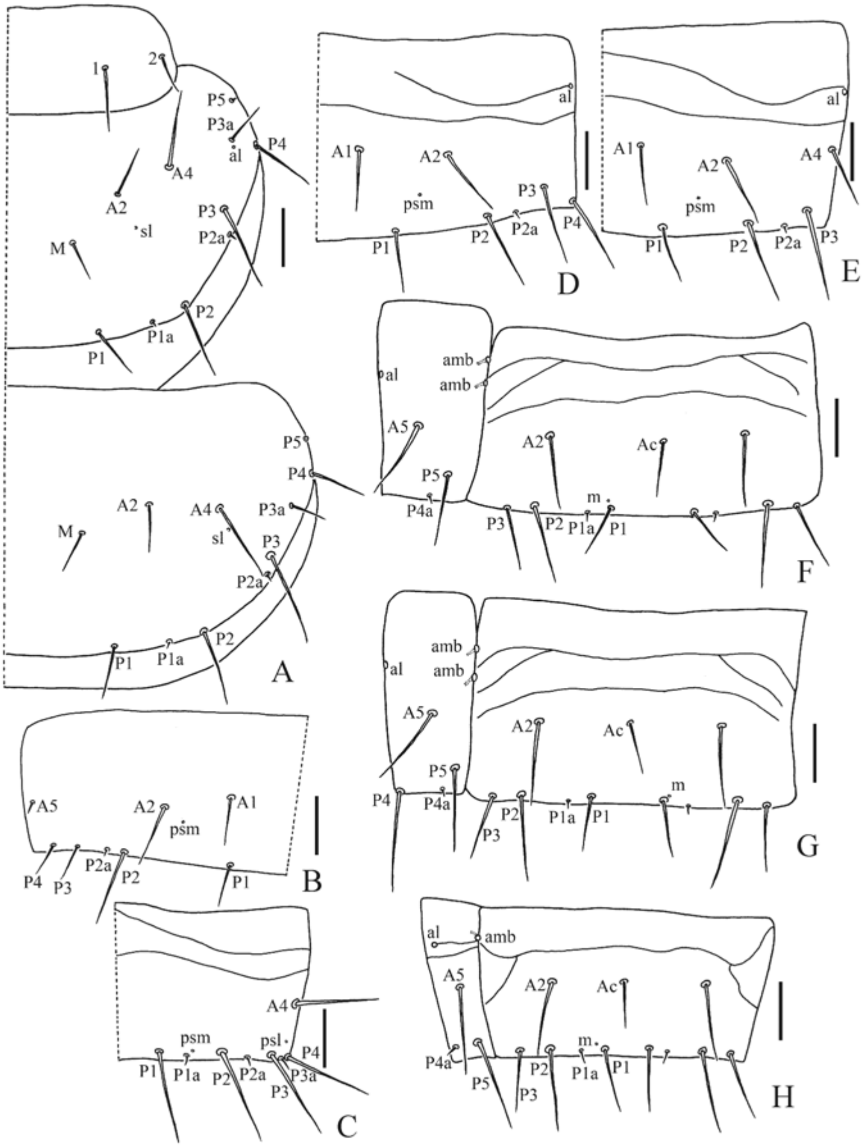

Figure 2. *Baculentulus wenyingae* **sp. nov.** holotype. A. Thorax, dorsal view, right side (*al* = anterolateral pore, *sl* = sublateral pore); B. Tergite I, left side; C. Tergite VII, right side; D. Tergite V, right side; E. Tergite VI, right side; F–H. Sternites V–VII. Scale bars = 20 μm.

Abdominal appendages with 4, 2, 2 setae, two glands and two pores present on each abdominal appendage I (Figs. 1E, F). Subapical setae and apical seta of second and third appendages 20–22 μm and 10 μm (Fig. 1F). Striate band on abdominal segment VIII reduced (Fig. 3I). Comb on abdomen VIII rectangular, with 8 short teeth (Fig. 1G). Female squama genitalis with pointed acrostyli (Fig. 1H).

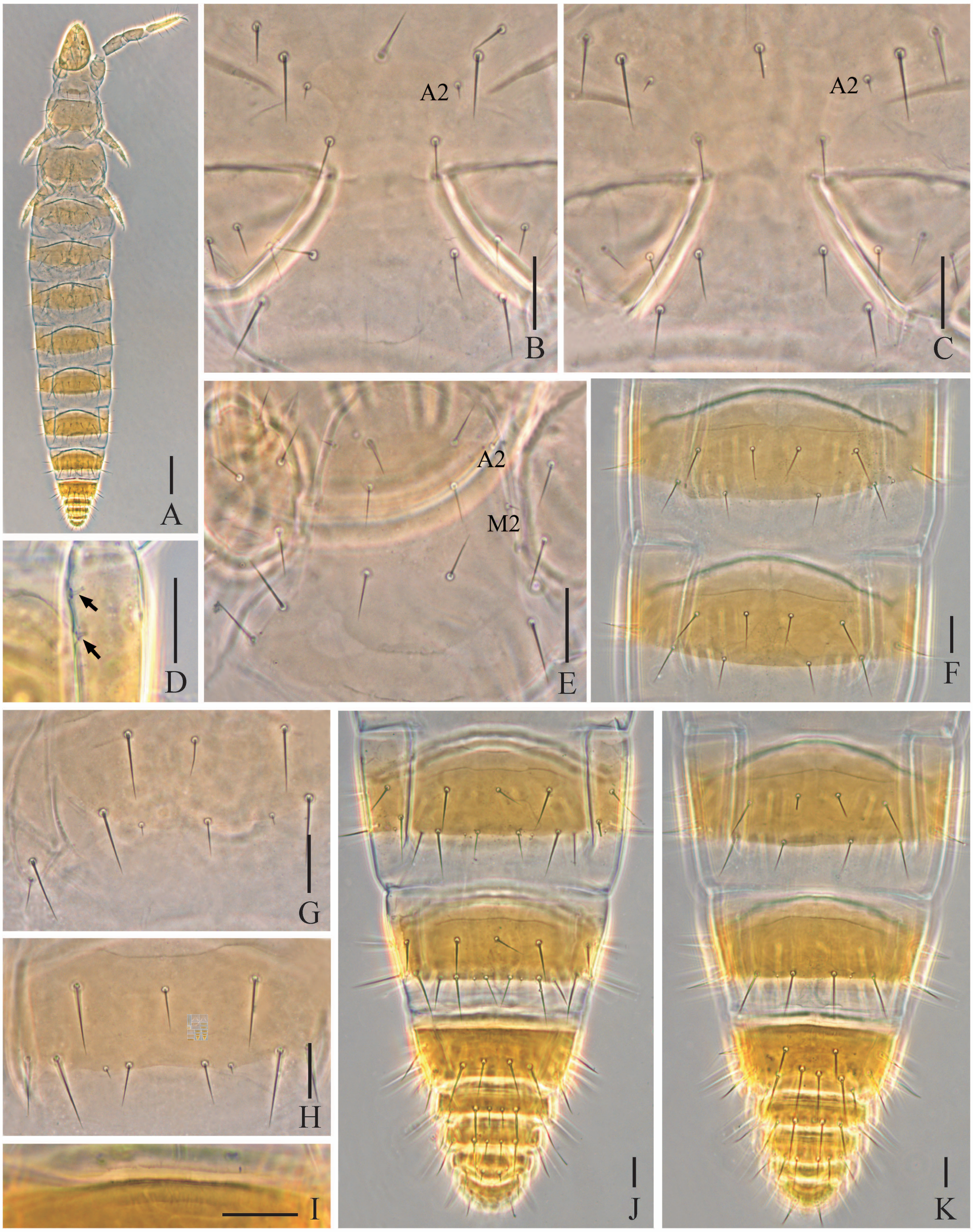

Figure 3. *Baculentulus wenyingae* **sp. nov.**, holotype. A. Habitus; B. Mesosternum; C. Metasternum; D. Part of tergite and sternite V, arrows show the anteromembranal (*amb*) pores; E. Prosternum; F. Tergites IV and V; G. Sternite II; H. Sternite IV; I. Striate band on tergite VIII; J. Sternites VI–XII; K. Tergites VI–XII. Scale bars = 100 μm (Fig. A); 20 μm (Figs. B–K).

Holotype. ♀ (slide No. ZJ-ZS-P2016001-1), **East China,** Zhejiang Province, Zhoushan City, Dinghai District, Mahuangshan hill, 30°03'N, 122°03'E, elev. 177 m, soil sample No. 3 from a broad-leaved forest beside a path, 06-VIII-2016, coll. Chengwang HUANG. **Paratype.** 1♀, 1 mj. (slide No. ZJ-ZS-P2016002), same data as holotype. All types are deposited in the Shanghai Natural History Museum (SNHM).

Diagnosis. *Baculentulus wenyingae* **sp. nov**. is characterized by the presence of foretarsal sensillum *b'*, the maxillary palp with one parallel-side and one leaf-shaped sensillum, the labial palp with one leaf-shaped sensillum, absence of *P1a* on tergites I–VI, with three pairs of *A*-setae on tergites I–V, four pairs of *A*-setae on tergite VI, two pairs of *A*-setae (*A4*, *A5*) and nine pairs of *P*-setae on tergite VII.

Etymology. The new species is dedicated to Professor Wenying YIN for her great contribution to the knowledge of Protura from China, and to express our great gratitude for her instruction during our study.

Distribution. East China (Zhejiang). Only known from type locality.

Remarks. There are 39 *Baculentulus* species described in the world so far (Bai & Bu 2013; Bu *et al*. 2014; Likhitrakarn *et al*. 2016; Yin 1999). *Baculentulus wenyingae* **sp. nov**. belongs to the group with foretarsal sensillum *b'* present. A key for the 10 species having foretarsal sensillum *b'* in the world was provided in Bai & Bu (2013). The new species in the present study can be easily separated from other species by the shape of sensilla on maxillary and labial palps, as well as the chaetotaxy on tergites I–VI (*P1a* absent) and tergite VII (4/18 setae). Thirteen *Baculentulus* species from China can be distinguished by the following key.

Key to *Baculentulus* species from China

1. Foretarsal sensillum *b'* present ··························· 2
-. Foretarsal sensillum *b'* absent ··························· 3
2. Seta *P1a* present on tergites I–VI ··························· *B. xizangense* Bai & Bu
-. Seta *P1a* absent on tergites I–VI ··························· *B. wenyingae* **sp. nov.**
3. Tergites I–VI without seta *P1a'* ··························· 4
-. Tergites I–VI with seta *P1a'* ··························· *B. bisetuli* Yin
4. Seta *P1a* absent on tergites I–VI ··························· 5
-. Seta *P1a* present on tergites I–VI ··························· 6
5. Tergite VII with 4 *A*-setae, foretarsus 38–41 µm ··························· *B. leptos* Yin
-. Tergite VII with 6 *A*-setae, foretarsus 100 µm ··························· *B. changchunensis* Wu &Yin
6. Tergite VI with 6 *A*-setae ··························· 7
-. Tergite VI with 8 *A*-setae ··························· 9
7. Tergite VII with 1 pair of *A*-setae ··························· *B. yunnanensis* Yin
-. Tergite VII with more than 1 pair of *A*-setae ··························· 8
8. Tergite VII with 2 pair of *A*-setae ··························· *B. breviunguis* (Condé)
-. Tergite VII with 3 pair of *A*-setae ··························· *B. loxoglenus* Yin
9. Tergite IV and V with seta *P5* ··························· 10
-. Tergite IV and V without seta *P5* ··························· *B. hohuanshanensis* Chao, Lee & Chen
10. Foretarsal sensillum *b* extremely long, reaching seta *γ*4 ··························· 11
-. Foretarsal sensillum *b* relatively short, not reaching seta *γ*4 ··························· 12
11. Foretarsal sensillum *f* surpassing base of claw, comb with 12 teeth ··························· *B. morikawai* (Imadaté & Yosii)
-. Foretarsal sensillum *f* reaching base of claw, comb with 6–8 teeth ··························· *B. tienmushanensis* (Yin)

12. Foretarsus 74–80 μm ·· *B. tosanus* (Imadaté & Yosii)
-. Foretarsus 104–122 μm ··*B. taipeiensis* Chao, Lee & Chen

Family Eosentomidae Berlese, 1909

Genus *Pseudanisentomon* Zhang & Yin, 1984

Pseudanisentomon Zhang & Yin, 1984: 59. Type species: *Anisentomon songkiangensis* Yin, 1977.

Diagnosis. Eosentomids with relatively large body size. Foretarsal sensillum *e* absent; *g* long spatulate; *t2* willow leaf-shaped or setiform; *f1* spindle-shaped. Tergite VIII with 6/9 setae. Sternite VIII with 0/7 or 2/7 setae. Female squama genitalis with S-shaped processus sternalis (Yin 1999; Galli *et al.* 2018).

Distribution. China; Japan.

2. ***Pseudanisentomon lishuiensis* sp. nov.** (Figs. 4–6, Table 2, 3)

Description. Adult body length 950–1150 μm (*n* = 4), pale yellow in color (Fig. 6A). Head elliptic, length 128–130 μm, width 95–100 μm (Fig. 4A). Head setae short, *d6* about 1.3–1.5× length of *d7*. Anterior additional seta (*aa*), *d4* and posterior additional (*pa*) present (Fig. 4A). Pseudoculus circular, width 9–10 μm, with three long lines and two short thick lines on surface (Fig. 4A). PR = 12–13. Clypeal apodeme distinct (Fig. 4A). Rostral seta simple, subequal to subrostral (Fig. 4B). Maxillary palpus with two sensilla, dorsal sensillum same length as lateral one (Fig. 4C). Labral seta present. Mandibles with three small distinct apical teeth (Fig. 4D). Digits of galea well-developed, median and inner equal, shorter and thicker than outer (Fig. 4D).

Foretarsus. Length 90–100 μm, claw length 17–20 μm, TR = 5.1–5.3; empodium same length as claw, EU = 0.8–0.9; S-shaped seta long. Dorsal sensillum *t1* short claviform, close to *α3*, BS = 0.75–0.8; *t2* slender and *t3* short. Exterior sensillum *a*, *c* short, subequal; *b* long; *d* short; *e* absent and *g* spatulate; *f-1* rod-shaped; *f-2* short (Fig. 4G). Two pores present at dorsal distal part of foretarsus. Interior sensillum *a'* slender and long, reaching base of *b'-1*; *b'-1* and *c'* short, filiform, without *b'-2* (Fig. 4H). Middle tarsus length 38–45 μm, claw length 13–15 μm. Hind tarsus length 45–55 μm, claw length 15 μm. Empodial appendages legs of II and III very short (Figs. 4E, 6E, F); basal seta (seta *D2*) of III leg of normal shape (Fig. 4E).

Thorax. Thoracic chaetotaxy given in Table 2. Setae *1* and *2* on pronotum 18–23 μm and 17–18 μm respectively. Spiracle diameter 6 μm. Tracheal camerae long and slender, 8–10 μm (Fig. 4F). On mesonotum and metanotum, *P1a* situated posterior to the row of *P1* and *P2*, *P1*, *P1a* and *P2* on mesonotum length 20–21, 20–21 and 25–28 μm, respectively. Metanotum with very short *P5a* adhere to *P5* (Fig. 4F). Sterna of thorax with no pores (Fig. 6B).

Abdomen. Abdominal chaetotaxy given in Table 5. Tergite I with two pairs of *A*-setae, six pairs of *P*-setae, *P3a* and *P4a* short, sensilliform (Figs. 5A, 6G). Seta *A3* on tergites V–VII absent (Figs. 5B, 6D). Seta *P1a* on tergites I–VI longer than *P1*, 26–28 μm (Figs. 5A; 6D, G); on tergite VII short (7–8 μm) and situated posteriorly to the level of *P1-P2* (Fig. 5B); *P2a* same length and shape as *P1a* on tergites II–VI. *P1a'* and *P2a* on tergite VIII short, 7–8 μm, sensilliform (Fig. 5C). Sternite VIII with one pair of anterior setae and seven posterior setae; sternites IX–X with two pairs of setae (Fig. 5D). Abdominal appendages on sternites I–III two-segmented (Fig. 6C). Tergites I–V with pores *psm*, VI–VIII without pores, IX and X each with 1 medial and 4 membranal pores, IX with 1 medial pore. Sternites I–X each with one medial pore (Fig. 5D), XI without pores. Segment XII with two anterior medial pores on tergite and one medial pore on sternite.

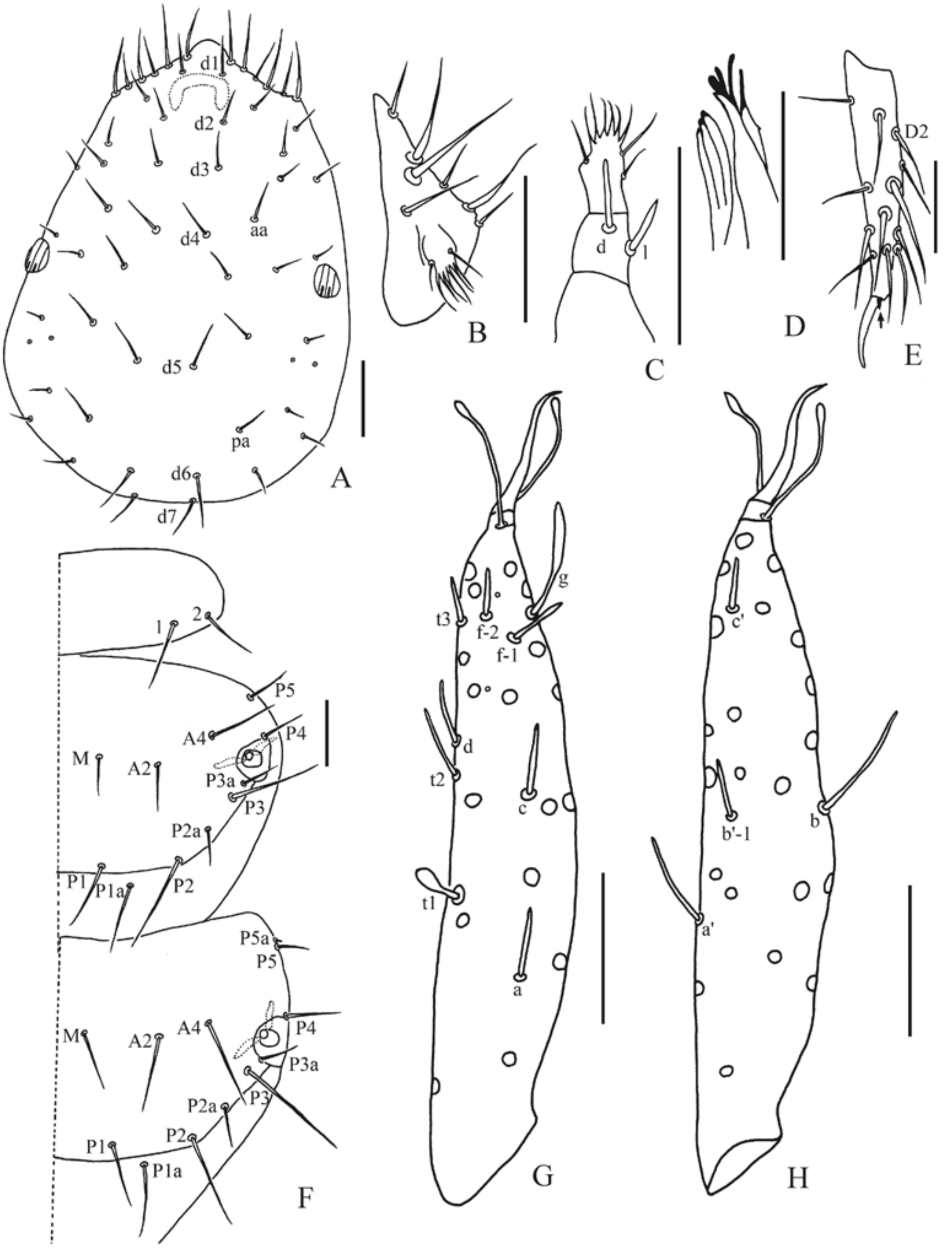

Figure 4. *Pseudanisentomon lishuiensis* **sp. nov**., holotype. A. Head, dorsal view; B. Labial palpus; C. Maxillary palpus; D. Mandible and digits of galea; E. Tarsus of hind leg; F. Thorax, dorsal view, right side; G. Foretarsus, exterior view; H. Foretarsus, interior view. Scale bars = 20 μm.

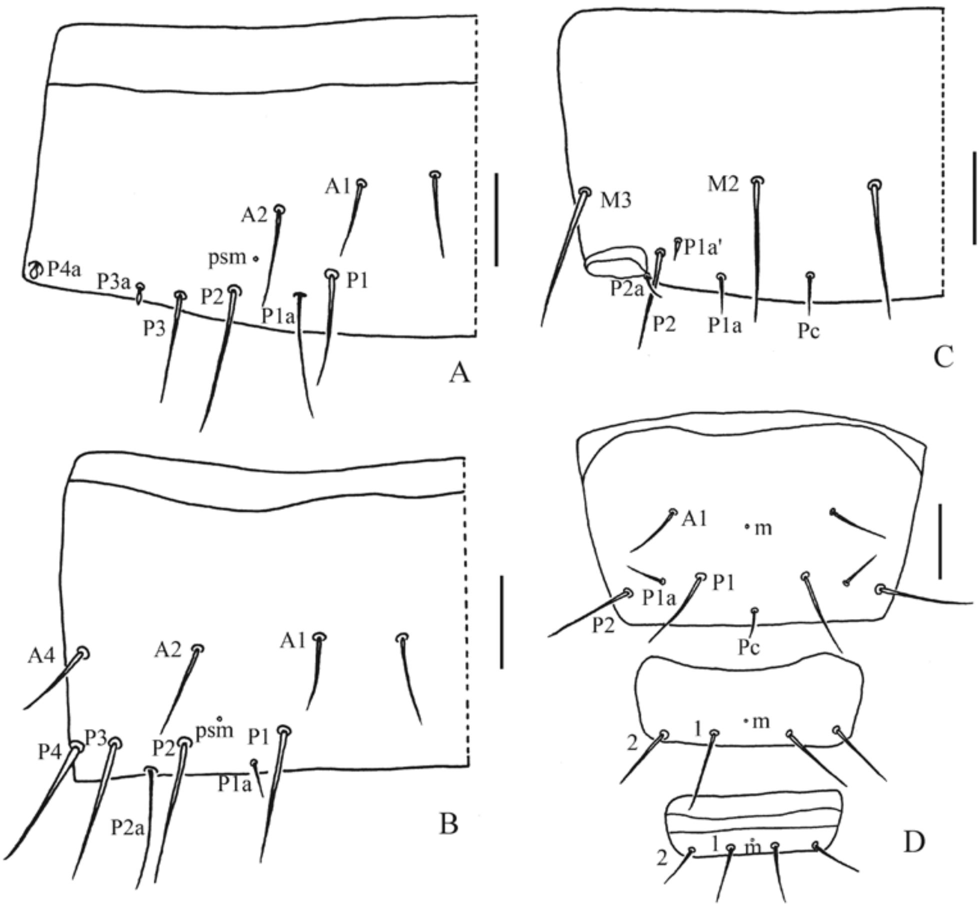

Figure 5. *Pseudanisentomon lishuiensis* **sp. nov**., holotype. A. Tergite I, left side; B. Tergite VII, left side; C. Tergite VIII, left side; D. Sternites VIII–X. Scale bars = 20 μm.

On female squama genitalis, caput processus big and curved towards the median edge of stylus, filum processus slim and long (Fig. 6H). Male squama genitalis with 3 pairs of dorsal and 2 pairs of ventral setae (Fig. 6I).

Holotype. ♂ (slide No. ZJ-LS-P2016001-2), **East China**, Zhejiang Province, Lishui City, Jingning County, Jiulongshan Geological Park, 41°30'N, 119°21'E, elev. 1200 m, soil samples from mixed forest, 8-VIII-2016, collected by Chengwang HUANG; **Paratypes.** 1♂ (slide No. ZJ-LS-2016001-4), same data as holotype; 2♀, 1 mj. (slide No. ZJ-LS-P2018001), **East China**, Zhejiang Province, Lishui City, Qingyuan County, Baishanzu National Nature Reserve, 27°35'N 119°5'E, elev. 1100 m, soil samples from a broad-leaved forest, 20-V-2008, coll. Ying YAN. All types are deposited in Shanghai Natural History Museum (SNHM).

Diagnosis. *Pseudanisentomon lishuiensis* **sp. nov**. is characterized by the absence of foretarsal sensillum *b'-2*, *b* longer than *c*, the empodial appendages of II and III legs very short, tergite I with 12 posterior setae, tergites V–VII lack seta *A3*, each with four pairs of anterior setae, sternites VIII–XI with chaetotaxy 2/7, 4, 4, 8 respectively; seta *D2* on leg III in normal shape.

Etymology. This new species is named after the type locality Lishui City.

Distribution. East China (Zhejiang). Only known from type locality.

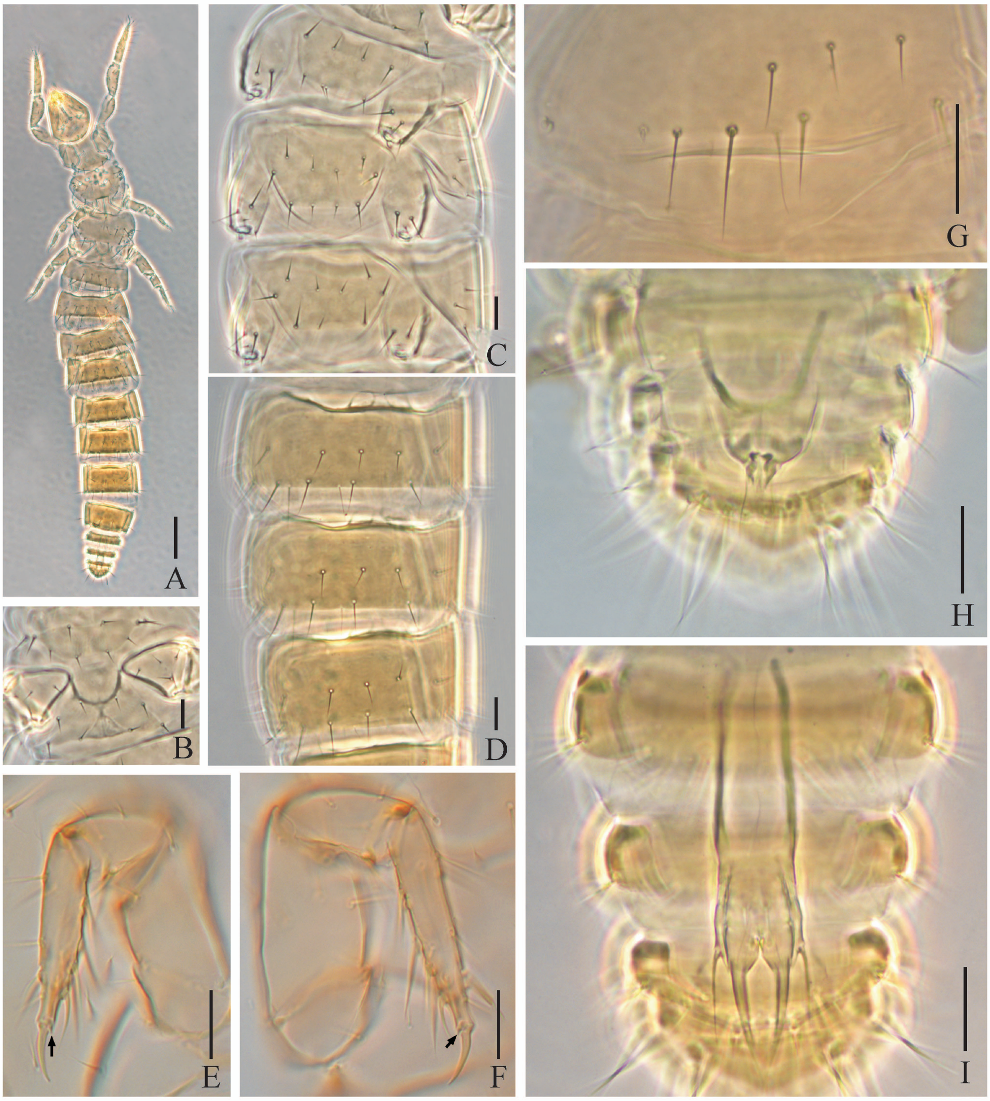

Figure 6. *Pseudanisentomon lishuiensis* **sp. nov**., holotype. A. Habitus; B. Metasternum; C. Sternites I–III; D. Tergite V–VII; E, F. Legs II and III, arrow shows empodial appendage; G. Tergite I; H. Female squama genitalis; I. Male squama genitalis. Scale bars = 100 μm (Fig. A), 20 μm (Figs. B–I).

Remarks. Among 17 species of the genus *Pseudanisentomon* Zhang & Yin, 1984 described in the world, 10 of them have two pairs of setae on sternites IX and X (Yin 1999). *Pseudanisentomon lishuiensis* **sp. nov**. is similar to *P. guangxiensis* (Yin & Zhang, 1982) in body chaetotaxy, with four pairs of *A*-setae on tergites V–VII (*A3* absent), and similar female genitalia. They can be distinguished by the length of empodial appendages of legs II and III, foretarsal sensilla, length of foretarsus, shape of pseudoculus, and the female genitalis (Table 3).

Table 2. Adult chaetotaxy of *Pseudanisentomon lishuiensis* sp. nov.

Segment		Dorsal		Ventral	
		Formula	Setae	Formula	Setae
Th.	I	4	1, 2	$\frac{6-2}{6}$	A1, 2, 3, M P1, 2, 3
	II	$\frac{6}{16}$	A2, 4, M P1, 1a, 2, 2a, 3, 3a, 4, 5	$\frac{6-2}{6}$	A1, 2, 3, M P1, 2, 3
	II	$\frac{6}{18}$	A2, 4, M P1, 1a, 2, 2a, 3, 3a, 4, 5, 5a	$\frac{6-4}{8}$	A1, 2, 3, M1, 2 P1, 1a, 2, 3
Abd.	I	$\frac{4}{12}$	A1, 2 P1, 1a, 2, 3, 3a, 4a	$\frac{4}{4}$	A1, 2 P1, 2
	II–III	$\frac{10}{16}$	A1, 2, 3, 4, 5 P1, 1a, 2, 2a, 3, 4, 4a, 5	$\frac{6}{4}$	A1, 2, 3 P1, 2
	IV	$\frac{10}{16}$	A1, 2, 3, 4, 5 P1, 1a, 2, 2a, 3, 4, 4a, 5	$\frac{6}{10}$	A1, 2, 3 P1, 2, 2a, 2a', 3
	V–VII	$\frac{8}{16}$	A1, 2, 4, 5 P1, 1a, 2, 2a, 3, 4, 4a, 5	$\frac{6}{10}$	A1, 2, 3 P1, 2, 2a, 2a', 3
	VIII	$\frac{6}{9}$	M2, 3, 4 Pc, 1a, 1a', 2, 2a	$\frac{2}{7}$	A1 Pc, 1, 1a, 2
	IX	8	1, 2, 3, 4	4	1, 2
	X	8	1, 2, 3, 4	4	1, 2
	XI	8	1, 2, 3, 4	8	1, 2, 3, 4
	XII	9		12	

Table 3. Comparison of *P. lishuiensis* sp. nov. with *P. guangxiensis* (Yin & Zhang, 1982)

Characters	*P. lishuiensis* **sp. nov**.	*P. guangxiensis* (Yin & Zhang, 1982)
Body length (µm)	950–1150	690–873
Foretarsus length	90–100	52–55
Empodial appendages of legs II and III	short, about 1/6 of claw	long, about 1/2 of claw
Pseudoculus	five lines	one line
Clypeal apodeme	distinct	indistinct
BS	0.75–0.8	0.8–0.9
Foretarsal sensillum *b'-1*	+	-
Foretarsal sensillum *b'-2*	-	+
Foretarsal sensilla *b* and *c*	*b* > *c*	*b* < *c*
Chaetotaxy of tergite I	4/12	4/10
Seta *P1a'* and *P2* on tergite VIII	normal	anterior placed

Discussion

In total, the 39 species of Protura recorded from Zhejiang Province belong to 14 genera and 7 families (Table 4). Most species (89.7%) belong to Eosentomidae (21 species), Berberentulidae (10 species) and Protentomidae (4 species), while the other four families are represented by only one species, respectively. Protura of Zhejiang Province are mainly composed of the species from the Oriental Region, similar to the Protura fauna from Hainan Island (Bu *et al.* 2019), but distinctly different from those from the Russian Far East and Siberia (Bu *et al* 2014; Shrubovych 2014).

Compared with other provinces of China, the diversity of Protura in Zhejiang Province is known better than in provinces of North and West China (for instance, Shanxi with 5, Inner Mongolia with 8, Xinjiang with 12, Qinghai with 10, Xizang with 13 and Ningxia with 15 species only). Zhejiang has the same number of species as Sichuan Province (39 species), which is only less than in Yunnan Province (80 species), but more than in Guizhou (36 species), Hainan (34), Hunan (34), Jiangxi (31), Anhui (31), Jiangsu (30) and Taiwan (29). Further investigations should be made in the poorly known areas so as to unveil the real diversity of Protura in China.

Table 4. Protura from Zhejiang Province and their distributions

Classification	Species	Distribution in Zhejiang
Order Acerentomata Yin, 1996		
Family Hesperentomidae Price, 1960		
Huhentomon Yin, 1977	*H. plicatunguis* Yin, 1977	Hangzhou, Shaoxing, Zhoushan
Family Protentomidae Ewing, 1936		
Neocondeellum Tuxen & Yin, 1982	*N. brachytarsum* (Yin, 1977)	Hangzhou
	N. chrysallis (Imadaté *&* Yin, 1979)	Hangzhou, Quzhou
	N. dolichotarsum (Yin, 1977)	Huzhou, Hangzhou, Quzhou
	N. wuyanensis Yin *&* Imadaté, 1991	Quzhou, Wenzhou
Family Berberentulidae Yin, 1983		
Polyadenum Yin, 1980	*P. sinensis* Yin, 1980	Hangzhou
Gracilentulus Tuxen, 1963	*G. meijiawensis* Yin & Imadaté, 1979	Huzhou, Hangzhou
Kenyentulus Tuxen, 1981	*K. ciliciocalyci* Yin, 1987	Huzhou, Hangzhou, Ningbo, Zhoushan, Quzhou
	K. dolichadeni Yin, 1987	Jinhua, Lishui
	K. henanensis Yin, 1983	Hangzhou
	K. japonicus (Imadaté, 1961)	Huzhou, Jiaxing, Hangzhou, Shaoxing, Zhoushan, Quzhou
	K. sanjianus (Imadaté, 1965)	Hangzhou
Baculentulus Tuxen, 1977	*B. tienmushanensis* (Yin, 1963)	Huzhou, Hangzhou, Ningbo, Zhoushan, Quzhou, Lishui, Wenzhou

Continued Table 4

Classification	Species	Distribution in Zhejiang
	B. tosanus (Imadaté & Yosii, 1959)	Hangzhou
	B. wenyingae **sp. nov.**	Zhoushan
Family Acerentomidae Silvestri, 1907		
Filientomon Rusek, 1974	*F. takanawanum* (Imadaté, 1956)	Hangzhou
Order Sinentomata Yin, 1996		
Family Fujientomidae Yin, 1983		
Fujientomon Imadaté, 1964	*F. dicestum* Yin, 1977	Hangzhou
Family Sinentomidae Yin, 1965		
Sinentomon Yin, 1965	*S. erythranum* Yin, 1965	Hangzhou
Order Eosentomata Yin, 1996		
Family Eosentomidae Berlese, 1909		
Zhongguohentomon Yin, 1979	*Z. magnum* Yin, 1979	Hangzhou
Eosentomon Berlese, 1909	*E. brevicorpusculum* Yin, 1965	Huzhou, Hangzhou
	E. chishiaense Yin, 1965	Hangzhou
	E. commune Yin, 1965	Huzhou, Hangzhou, Ningbo, Zhoushan, Quzhou
	E. dissimilis Yin, 1979	Hangzhou
	E. margarops Yin & Zhang, 1982	Quzhou
	E. megaglenum Yin, 1990	Hangzhou, Quzhou
	E. orientale Yin, 1965	Hanghzou, Ningbo, Zhoushan, Quzhou
	E. sakura Imadaté & Yosii, 1959	Hanghzou, Ningbo, Zhoushan, Quzhou, Lishui, Wenzhou
	E. shanghaiense Yin, 1979	Hangzhou, Ningbo, Quzhou, Lishui, Wenzhou
	E. unirecessum Yin, 1979	Hangzhou
Anisentomon Yin, 1977	*A. chinensis* (Yin, 1965)	Hangzhou
	A. heterochaitum Yin, 1977	Huzhou, Hangzhou
	A. magnispinosum (Yin, 1965)	Hangzhou
Pseudanisentomon Zhang &Yin, 1984	*P. lishuiensis* sp. nov.	Lishui
	P. meihwa (Yin, 1965)	Hangzhou, Zhoushan
	P. minystigmum (Yin, 1979)	Hangzhou, Quzhou
	P. sheshanense (Yin, 1965)	Hangzhou
	P. trilinum (Zhang & Yin, 1981)	Hangzhou, Quzhou
	P. wanense Zhang, 1987	Hanghzou, Zhoushan, Quzhou
Neanisentomon Zhang &Yin, 1984	*N. tienmunicum* Yin, 1990	Hangzhou

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